DRYLET

helping nature do its job®

GLOBAL WATER AWARDS 2018 FINALIST
Breakthrough Water Technology Company of the Year

wexglobal 2018
Water and Energy Exchange Technology Award

wef 2017
Innovative Technology Award

InnoSTARS
2017 First Prize

Drylet redefines data and microbiology use to optimize water and sewage treatment.

ABOUT DRYLET

Drylet is the award-winning developer and manufacturer of an advanced biocatalysis particle for delivering microbes. Founded in 2013, the venture-backed, high-growth company is headquartered in Houston, Texas, with offices in Europe and China. Drylet's technology reduces biosolids between 30% and 60+% in municipal wastewater treatment and livestock production facilities. Easy-to-use and scalable, Drylet's products require no capital expense.

ABOUT DRYLET'S SOLUTION

- Engineered, porous, non-toxic particles loaded with beneficial microbes
- 140,000 m2 of surface area covered with microbes per kilogram of product
- Beneficial microbes at 100x density of competing liquid products
- 40+ percent reduction of solids, hydrogen sulfide, odor, among other benefits
- Easy dry application, no mixing required
- No capital expense required

MUNICIPAL WASTEWATER

Aqua Assist is added daily as part of a facility's routine maintenance program. It boosts the biological processing by more than 50%, reducing biosolids and improving operations.

INDUSTRIAL WASTEWATER

Bio React has been especially formulated to consume fats, oils, greases, and sludge in industrial systems, slashing BOD and eliminating solids build-up.

LIVESTOCK PRODUCTION

ManureMagic® reduces solids in swine manure deep pits, lagoons, and pull-plug systems. A Purdue University study found it lowers H2S and odor by 50% and 43% respectively.

OIL & GAS

MB Bio delivers billions of live microorganisms for bioremediation of oil, gasoline, diesel, grease or any other hydrocarbo-based contamination.

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AQUA ASSIST

Case study of a 15,000-m3/day WWTP show sludge reductions between 24% and 41%, and significant savings in operating costs

Dry solids reduction benefits at 15,000-m3/day Atascocita MUD #109:

- 29% inflation adjusted reduction in hauling costs
- 43% savings in polymer usage
- extended equipment life cycle with fewer repairs and fewer maintenance hours
- x3 carrying capacity increase without impacting effluent quality and compliance requirements

Source: Brown and Gay Engineers

Learn more at www.drylet.com/aa

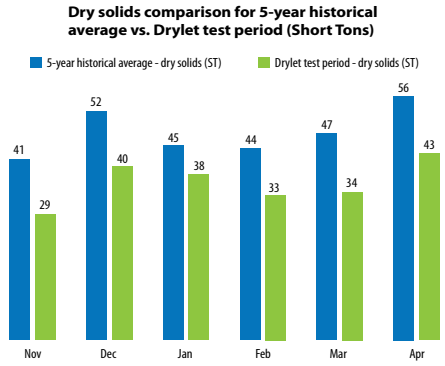


Figure 1. 5-year historical monthly average of dry solids produced at 15,000-m3/day WWTP compared against the total dry solids produced each month during Drylet testing period. *Source: Brown and Gay Engineers*

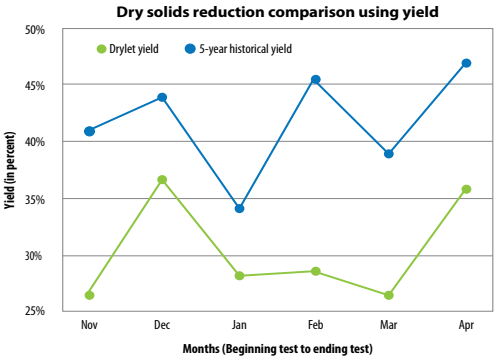
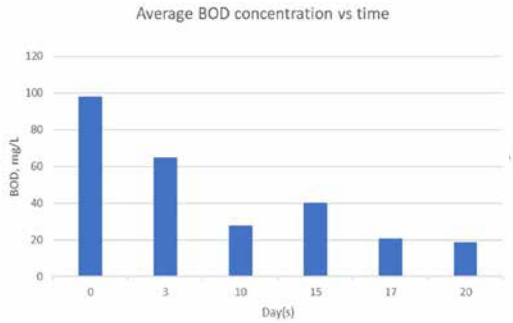


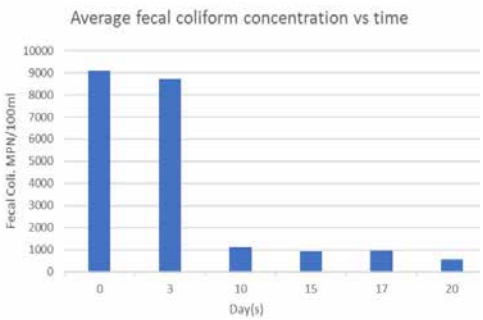
Figure 2. 5-year historical yield at 15,000-m3/day wastewater treatment plant compared against Drylet testing period yield for each month (lower yield indicates less dry solids produced each month). *Source: Brown and Gay Engineers*

BIO REACT

BOD, fecal coliform concentration slashed 81% and 94% in dairy processing wastewater lagoon

Just 20 days of shock-dosing this Canadian cheese manufacturer's lagoon with Bio-React at 50 pounds per million gallons of capacity led to dramatic improvements. The company was able at last to discharge the effluent without risking any penalty. It has been using an ongoing treatment protocol of 1 pound of Aqua Assist added to the influent daily ever since.





manure magic

Swine manure case study: Over 60% solids reduction in one year

www.manuremagic.com

In May 2016, 57 kilograms of ManureMagic® were applied to the test lagoon fed by four 1,000-head hog barns at a major hog production company. Another 57 kilograms were also applied to the barns' pull-plug pits over the course of four months. Lagoon sludge levels were measured in June, then in September, at nine identical locations in both the treated and control lagoons. The levels of the lagoon treated with ManureMagic were down 10% within a month, with each point falling between 15 cm and 30.5 cm. By the end of September, they had dropped 42% on average, with individual levels dropping 45.7 cm and 76.2 cm (see Figure 1). Measurements taken nine months later, in June 2017, revealed a further 44% drop average, with no product added over that timeframe, bringing the total reduction rate to over 60% in one year. Meanwhile, the control lagoon remained unchanged over the whole period.

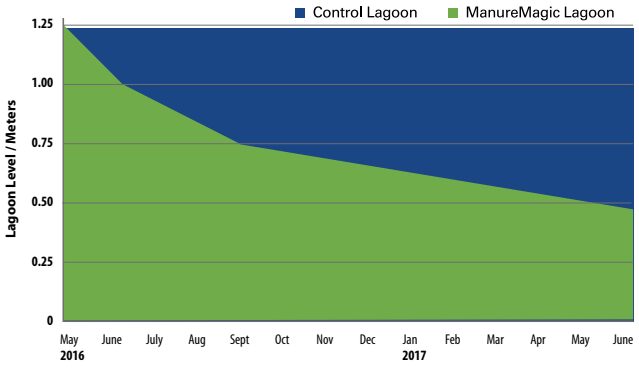


Figure 1. ManureMagic® field trial compared two identical lagoons at 26.5-million liter capacity at a major hog production company for a 4-month period. The biological process remained active after the end of the trial, with a drastic drop in sludge levels over 9 months after the last dose of product was added—this despite more solids being flushed into the lagoon on a weekly basis.

DRYLET

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Aqua Assist reduces biosolids volume up to 78% and slashes costs at Massachusetts plant

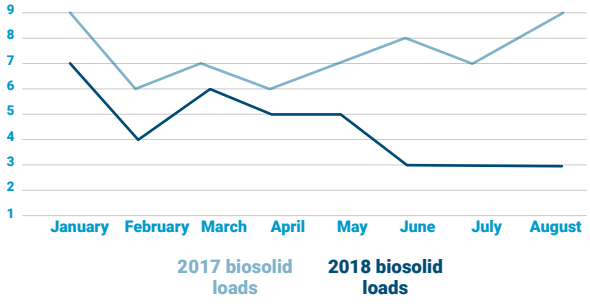
> **We found a simple solution to our escalating sludge-hauling problem that had a significant impact cost, while giving us no bulking, no rising solids in the clarifier, excellent denitrificaiton, very low nutrient numbers and BOD values, all without infrastructure changes or additions.**
>
> **Keith Milne | Chief operator | Town of Deerfield Wastewater Division in South Deerfield Massachusetts**

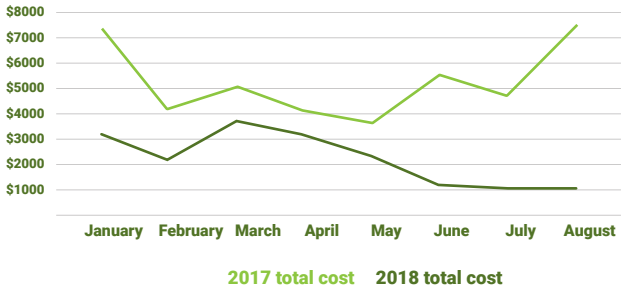
GROWING SAVINGS EVERY MONTH

During the course of 2017, South Deerfield hauled away 86 9,000-gallon loads hauled at an average cost of $804 per load—a monthly average of seven loads for $5,762. With Aqua Assist in full swing, the plant can skip waste pickups and is seeing increasing savings each month:

- **June 2018:** Sent out two loads at a cost of $2,441—compared to eight loads in June 2017. With the $500 monthly subscription to receive the Aqua Assist product and support services, the monthly net savings over the previous June was $2,789.
- **July 2018:** The volume of sludge pickups decreased by more than 70% (18,000 gallons in July 2018 vs. 63,000 gallons in July 2017). The plant paid 49% less for disposal fees.
- **August 2018:** The plant reduced biosolids volume by 78% and cut disposal cost by 68% compared to August 2017.

SOUTH DEERFIELD BIOSOLIDS LOADS AND HAULING COSTS (2017 VS. 2018)





43%
monthly average biosolids reduction for 2018 vs. 2017

$4,635
monthly net savings in August 2018 over August 2017

The costs of managing wastewater sludge—between hauling, landfilling and incineration fees—are escalating exponentially. In recent years, the South Deerfield wastewater treatment plant in Massachusetts has faced tripling waste-hauling costs as more landfills and incinerators near the plant close. The chief operator was searching for a solution to reduce the volume of biosolids and the frequency of waste pickups. He learned about Drylet's Aqua Assist through a trade publication article.

THE AQUA ASSIST DIFFERENCE

How Aqua Assist operates

Aqua Assist is a dry-to-the-touch product formulated with engineered inorganic and porous particles seeded with mixed microbial cultures. Aqua Assist boosts the processing power of wastewater treatment plants by accelerating the natural breakdown of biosolids into water and CO2. Operators add Aqua Assist to the aeration basin at an average daily dose of 2 lb per 1 MGD—with no mixing required.

A subscription trial without capital investment

Drylet's subscription model allowed the South Deerfield plant to experiment with Aqua Assist with the confidence of a satisfaction guarantee. The three-month subscription trial started in November 2017 and provided product based on the plant's size, flow and configuration, along with technical support and assistance. No capital investment was required. At the start of the trial, Drylet used its data modeling software to configure a digital replica of the plant based on historical operational and process data from South Deerfield. The modeling tool informed recommendations for product application and enabled the plant to launch its trial with Aqua Assist during winter, when lower temperatures and higher salt levels create challenging conditions for biological activity.

To jump start the population of Aqua Assist microbes in the system, the plant began by adding 2 lb of product per day to the aeration tank at the splitter box, where the influent and RAS flows meet ahead of the aeration tank. After the initial weeks, the dosage was reduced to 1 lb per day.

Small operational changes drive success

Drylet provided regular customized guidance on operational practices that would complement the regimen of Aqua Assist, including techniques for suspended solids and the clarifier blanket. Prior to using Aqua Assist, the plant ran a mixed liquor suspended solid level (MLSS) level of 2,800 to 3,400 mg/L during the warm season and 3,400 mg/L to 4,000 mg/L in winter. South Deerfield scoured out the bottom of the final clarifier and kept all the sludge in the aeration tank where it could do the most work. Drylet requested that the plant let its MLSS climb to 4,000 and eventually 5,000 mg/L—new territory for the operator. The support team also recommended keeping a larger blanket of sludge in the final clarifier to help with BOD removal and give the microbes more time to reduce the biosolids inventory.

Weekly conference calls with the Drylet account manager to discuss status, results and next steps delivered ongoing guidance for success. The recommendations steered the plant into new approaches, and operating differently worked. By stepping out of their procedural comfort zone, operators at the plant were able to amplify the effectiveness of the product and achieve major results —all without any risk to regulatory compliance.

HOW THE SOUTH DEERFIELD PLANT OPERATES

- **Structure:** A small, extended aeration facility with no headworks; one mechanical, floating surface aerator; and one small circular final clarifier.
- **Size:** Average sludge wasting batch is 20,000 gallons.
- **Process:** The return activated sludge pumps turns off, allowing the solids to build up in the clarifier for several hours. The waste is moved to a sludge holding tank, introducing a coagulant along the way.

Mixed liquor sample from the aeration tank at the South Deerfield wastewater treatment plant showing smooth, compacted sludge with strong settling properties and crystal clear effluent.

AQUA ASSIST | DRYLET

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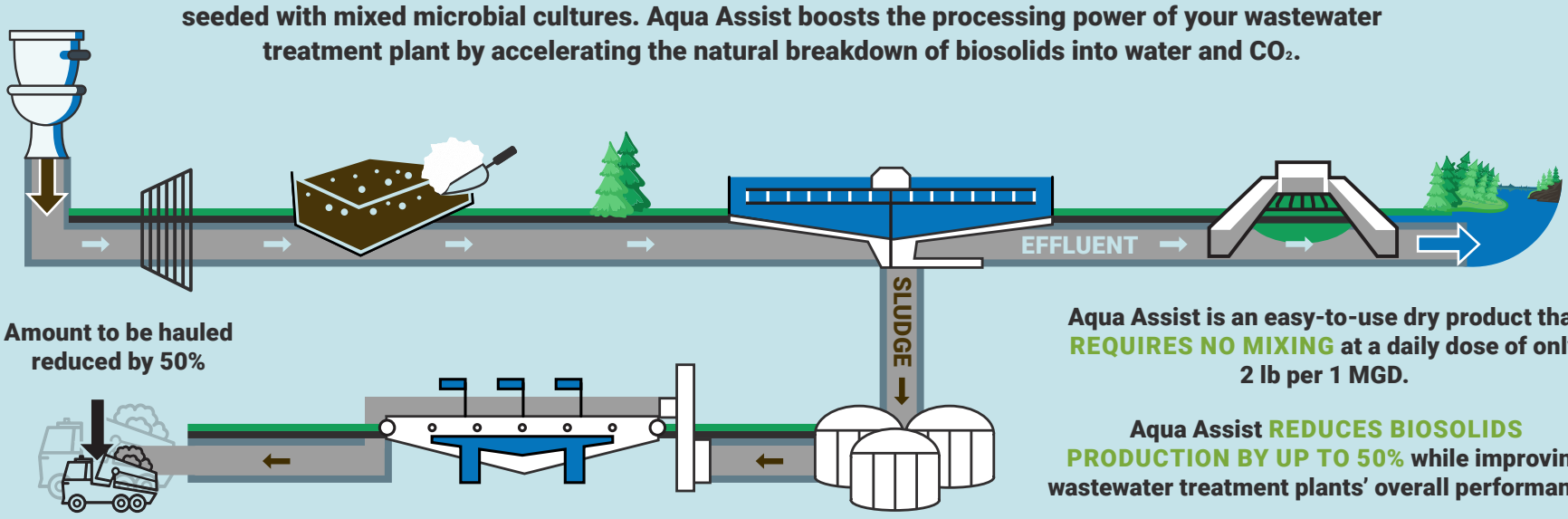
OVERVIEW

BOOSTING WASTEWATER TREATMENT WITH AQUA ASSIST

Aqua Assist is a dry-to-the-touch product formulated with engineered inorganic and porous particles seeded with mixed microbial cultures. Aqua Assist boosts the processing power of your wastewater treatment plant by accelerating the natural breakdown of biosolids into water and CO_2.



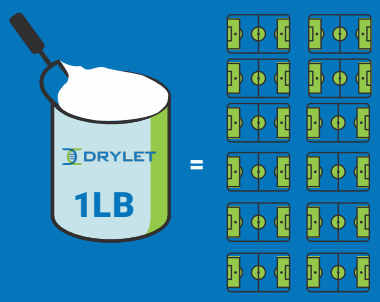
Aqua Assist is an easy-to-use dry product that REQUIRES NO MIXING at a daily dose of only 2 lb per 1 MGD.

Aqua Assist REDUCES BIOSOLIDS PRODUCTION BY UP TO 50% while improving wastewater treatment plants' overall performance.

HOW IT'S DIFFERENT

Many wastewater treatment plants are operating at or near their maximum capacity. The more biosolids they process, the higher their operating costs and the bigger the strain on their systems.

OUR PARTICLES PROVIDE 100X MORE DENSITY



Every pound of product provides the equivalent of 12 football fields of surface area loaded with beneficial micobes, 100x more microbes per gram than liquid cultures.

OUR PARTICLES SINK

Go straight to the food source and improve flocculation.

OUR PARTICLES IMPROVE OPERATIONS

A high-performing microbial community means smoother operations and easy compliance with permit requirements.

OUR PARTICLES IMPROVE RESILIENCE

Improved settling leads to demonstrated higher resilience in the face of extreme weather events such as hurricanes and floods.

OUR PARTICLES REDUCE BIOSOLIDS BY UP TO 50%

Less biosolids translates into savings on sludge processing and disposal.

HOW YOU BENEFIT

LESS SPENDING

MORE CONTROL

NO CAPEX

Aqua Assist is cost effective and zero footprint, saving resources, improving operational efficiency, and reducing environmental impacts—all without capital investment.

JUST ADD SCOOPS OF THE PRODUCT AND LET NATURE DO ITS WORK.

AQUA ASSIST

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Biosolids reduction must be first priority

Source reduction is the first step toward achieving a circular economy. A partnership between the Hoyo Group in China and the US company Drylet, creator of an innovative biocatalyst solution that reduces sludge volumes by 50 percent, is helping Chinese cities such as Nanjing to cost effectively improve wastewater management. Drylet CEO Luka Erceg explains.

An entire industry has sprouted to provide solutions for managing sludge. The circular economy approach has been guiding efforts to convert that waste stream into a resource stream for energy generation, agricultural compost, and other applications. Extracting nutrients from biosolids is an important part of the wastewater treatment equation, but it is a long way from a complete solution. The 2017 edition of the *United Nations World Water Development Report*, "*Wastewater: The Untapped Resource,*" points out that only 5 to 15 percent of the available nitrogen in wastewater can be recovered. Despite significant technological advances in nutrient recovery, the report shows that business opportunities remain limited, primarily due to lack of markets. Reuse can't be the first line of defense when there's too much waste to handle.

Low nutrient recovery and low demand combined with overwhelming volumes lead to the vast majority of wastewater sludge ending up in landfills, where it emits greenhouse gases (GHG). About half of the sewage sludge produced in the United States is landfilled – a large financial and environmental price that is unsustainable, with hauling transportation costs and landfill tipping fees in addition to their associated GHG emissions. In Europe, up to 80 percent of sludge is dumped in landfills or fields, or it is incinerated. Reuse is insufficient for the problem it's charged with remedying.

The waste management hierarchy is a guiding principle of industry, yet the current circular economy approach ignores its foundation: source reduction is the best first step. Minimizing the amount of biosolids that need to be processed reduces strain on infrastructure and addresses the root of the escalating problem. As the global population continues to grow, the volume of biosolids produced will continually exceed the world's capacity to reuse. There is no more prescient example than China, a country whose population is at 1.5 billion and growing, and whose wastewater management issues are intensifying.

Cities such as Nanjing will facilitate a 100 percent diversion of biosolids.

Chinese cities adopt reduction strategy

China's wastewater treatment industry generates 22 million tons of sludge every year, which overwhelms its processing capacity. In fact, in 2013, Beijing's largest wastewater treatment plant was illegally dumping its biosolids waste in the city's outskirts, a problem replicated in other large urban areas such as Guangzhou, Shenzen, and Shanghai. China has since taken steps to address its biosolids dumping problem. The city of Xiangyang in Central China is one of the few Chinese cities to build a biogas plant to generate energy from organic waste such as biosolids. This is a great first step, but most municipalities don't have the financial resources or infrastructure available to turn all of their biosolids into energy.

For this reason, cities in China are starting to see reduction as a primary biosolids management strategy and embracing innovations that help them implement it. The Nanjing Hoyo Municipal Utilities Investment Administration Group took steps toward making source reduction a priority by signing a partnership with Drylet to create a joint venture to distribute in China their proprietary biocatalyst, which is manufactured in the United States. The biocatalyst boosts nature's processing power with a protective substrate for sludge-eating microbes, reducing biosolids volumes by up to 50 percent. These biocatalysts provide 12 football fields of solid area covered with microbes per pound of product, offering 100 times the colony-forming units per gram compared to a liquid culture. Protected by the substrate, the microbes reproduce at an accelerated rate, feeding off the organic waste in a frenzy, and converting solids into water and gas. By changing the microbial environment at the wastewater treatment plant with effective, non-toxic enhancements for activated sludge, the Aqua Assist product is an alternative to harsh chemicals, which helps customers shrink their environmental footprint without capital investment.

China's latest 5-year plan identified wastewater treatment as a top priority, and new regulations are increasing demand for technologies including biological denitrification and membrane filtration that support or integrate into wastewater treatment. Drylet's introduction to the Chinese market started through a United States Department of Commerce water-focused mission in June 2017, when the company began sharing its approach to biosolids reduction. The partnership with the Hoyo Group was formalized during the US trade mission to China in November 2017, which invited 29 US companies, including Drylet, among the 100 that applied to accompany Commerce Secretary Ross and President Trump to Beijing.

Based in the second largest city in the east region of China, Hoyo takes a holistic approach to urban planning, specializing in low carbon, intelligent construction and operation of municipal infrastructure throughout the country. Hoyo sees the power of reduction as a sustainable solution and has also committed to joining Drylet as an equity investor. As part of its strategic relationship, Hoyo is setting up trials with Drylet's Aqua Assist product at the Nanjing wastewater utility, which fits into the organization's larger strategy. Hoyo is the leading public-private partnerships (PPP) player in the Chinese municipal utilities market and is actively expanding its PPP platform to include innovative technologies as water and wastewater treatment demand throughout the country becomes more acute. Drylet's partnership with Hoyo is expected to generate tens of millions of dollars in annual revenues in China and will help to address the remediation of sewage treatment plants, lakes, rivers, and other public water projects.

While treating waste as a resource helps create a closed loop system, the reality is that reduction is the first step to keeping waste out of landfills. The endorsement of Drylet's wastewater remediation technology by the Hoyo Group speaks volumes about China's readiness to embrace innovative solutions to managing its growing waste problems. Cities such as Nanjing that adopt a combined approach of reduction and recycling will facilitate a 100 percent diversion of biosolids. Wastewater utilities need to start embracing the policies and technologies that stop waste volumes from becoming an issue in the first place.

Author's Note

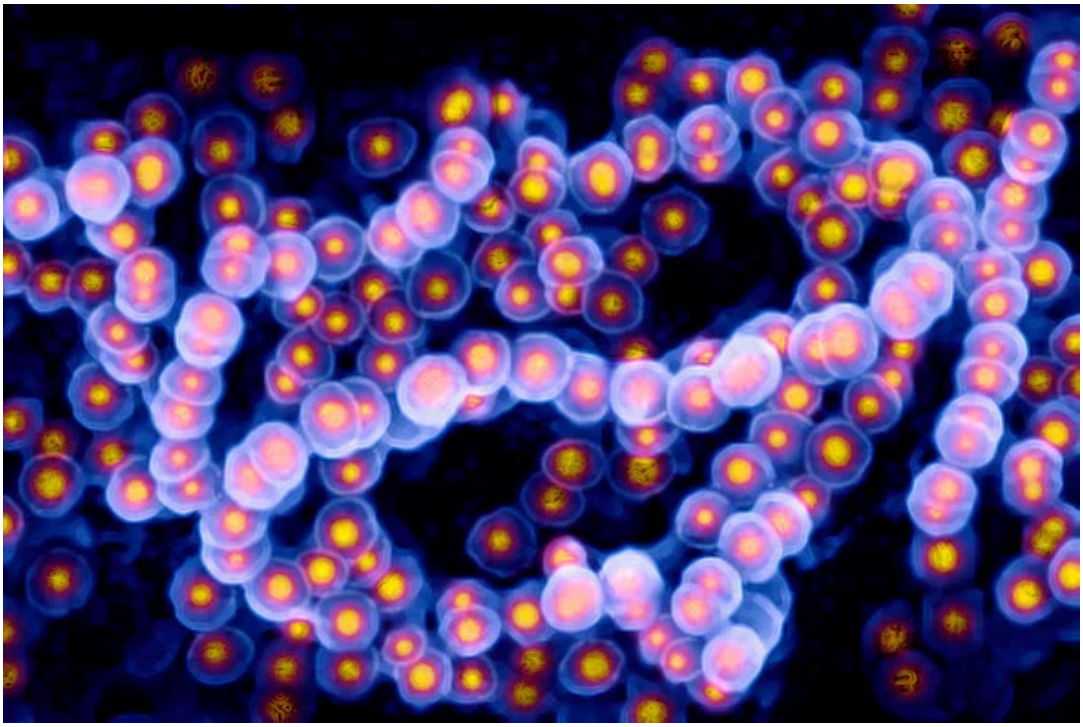
Luka Erceg is the president and chief executive officer of Drylet, Inc., based in Houston, Texas, United States.

Observations

I Lost My Arm to Microbes, but They Can Save the World

Exploring their hidden realm could uncover solutions to our most pressing problems

By Luka Erceg on May 17, 2018



Streptococcus bacteria. *Credit: Getty Images*

In my line of work as CEO of a bioremediation technology company that uses microbes for wastewater treatment, I'm keenly aware of the value microbiology brings to society.

encounter with little effect, to attack me—a lethal one-two punch. I narrowly escaped with my life.

The bacteria infected my left arm, and progressed so quickly that the doctors were forced to complete a left shoulder disarticulation, which completely removes the arm from the humeral head, to prevent the bacteria from taking hold in my chest and attacking my vital organs. It took the microbes less than three days to progress from the initial assault to threatening my life, all while I was under some of the best medical care and supervision in the world.

Obviously, the experience has permanently altered me, but it also left an indelible impression as an example—an extreme one, to be sure—of the power these tiny creatures have over how we live. Most importantly, it reinforced my belief that harnessing microbial power can do almost unimaginable good for our civilization.

Microbes are in the air we breathe; they cover every inch of our skin and the ground we walk on. In fact, an estimated one trillion species of microbes live on our planet, and 99.999 percent of them have yet to be discovered. Humans have always coexisted with microscopic life, but it's only now that we're realizing their potential to help solve our most pressing problems—and we've barely scratched the surface. With its intricate embedded functions, microbiology is nature's operating system. Investigations into and developments in microbiology decipher this operating system and create "hacks" that can help us.

We often follow the precautionary principle to our detriment when it comes to nature's mysteries, equating the unknown with danger. Over the past century, we've turned microorganisms in all their forms (bacteria, fungi, viruses) into enemies that must be sterilized and cleansed from our lives.

Instead, let's reframe the unknown qualities of microorganisms to focus on their potential instead of their dangers. Scientists are now exploring the niche processes and surprising functions that come from microbial interactions. Through 21st-century technologies such as low-cost DNA sequencing, we've begun to understand the secret world of microbes and their potential to serve us.

Tapping into the power of microbes has established new roles for these tiny life forms in mediating humans' conflicted relationship with our environment. For example,

phosphate to replace chemical fertilizers. Essentially, microbes can help us safely provide for ourselves.

Microbes can also help shrink our waste. Humans have managed to generate more than 9 billion tons of plastics since 1950, creating a plastic garbage patch floating in the Pacific Ocean that is nearly twice the size of my onetime home of Texas. Plastic left to its own devices takes more than 400 years to degrade, but newly-discovered bacteria can break down the polyethylene terephthalate, or PET, that makes up disposable water bottles, frozen-dinner trays and even polyester clothing.

Bioremediation techniques have been employing specialized bacteria for decades to degrade targeted pollutants, including oil and other petroleum products and solvents and pesticides found in soil or groundwater. New tools can boost nature's processing power by creating a more favorable environment that enhances the activity of microbes already living at the contaminated sites.

Today we have more powerful technologies than previous generations could have imagined. Thanks to advances in the medical field, I not only survived my intense fight with flesh-eating bacteria, but I expect to regain many of my physical abilities over time thanks to continued advances in robotics and materials science for artificial limbs. Although today's commercially available prosthetics have just scratched the surface of what's possible, they will one day be receiving brain signals that previously controlled my biological arm to operate a "bionic arm."

Research and investment make such astounding innovations possible. With more resources, we can apply 21st-century technology to unlocking the power of microorganisms for good and expanding explorations into their unique abilities to tackle humankind's biggest challenges. Given the speed and potency of microbial interactions, which I know from personal experience, their problem-solving potential is almost incomprehensibly large.
Let's go down the microbial rabbit hole and take on the future with nature.

Luka Erceg is CEO of Drylet, a bioremediation technology company that combines microbiology and material science.

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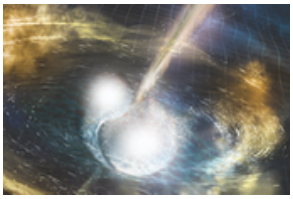

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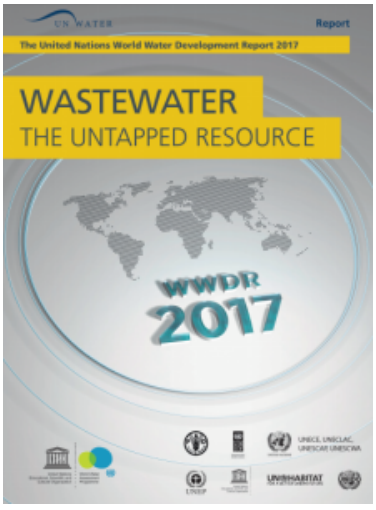
From burden to opportunity: How microbes can help shift the paradigm for wastewater in the circular economy

By **Editorial** - May 24, 2018

In an Expert Focus article for WaterbriefingGlobal, Dr. Malcolm Fabiyi, Chief Operations Officer and Vice-President of Operations at wastewater remediation technology specialists Drylet, discusses how microbes can help turn wastewater into a valuable resource and play a key role in the circular economy.



Dr. Malcolm Fabiyi: *Last year, the UN published a report called* ***"Wastewater: The Untapped Resource"*** *advocating a global paradigm shift to viewing the vast quantities of domestic, agricultural and industrial wastewater discharged everyday as a valuable resource rather than a costly problem.* One of the key issues covered in the report included taking a systems approach to wastewater by-product recovery and resource recovery from wastewater and biosolids. Wastewater is described in the report as "now poised to play a critical role in the context of a circular economy."

The circular economy closes the loop on waste streams by reusing them in new processes. Globally we consume about 140 billion gallons of water each day for routine activities like cooking, bathing and washing clothes. Annually, this results in 2 million tons of phosphorous,10 million tons of ammonia and 100 million tons of organic matter – a veritable gold mine of resources that can be reused in a variety of industrial and agricultural applications. The crux of the circular economy potential for wastewater lies in its by-products, specifically biosolids.

Technologies that optimize the quantity and quality of nutrients recovered from wastewater and unlock the renewable energy value in the biosolids by-product are key to developing the circular economy for wastewater. Some of the most exciting technologies that are being utilized leverage a basic building block of nature – microbes.

Transforming treatment plants into resource recovery centers

Governments and industry largely view wastewater treatment as a necessary cost that they absorb because it is mandated by regulation. Shifting the view of wastewater treatment from a cost burden to a revenue-generating opportunity will help reduce the expense of building and maintaining water and sewage infrastructure .To fully capture the resource potential of wastewater, we need to first advance innovation that optimizes treatment and recovery processes.

The agriculture industry is an ideal end-market for biosolids because of their nutrient density, and many new treatment technologies no longer focus solely on removing contaminants like phosphorous and nitrogen, but on converting them into recoverable forms for use as fertilizer. Targeted microbes applied at the right time during the wastewater treatment process can increase the quantities of nitrogen and phosphorous recovered.

Over the past two decades, an increasing number of wastewater treatment facilities have been utilizing their biosolids as a source of energy. The Newtown Creek Wastewater Treatment Plant in New York City uses its biosolids for energy production using co-digestion, which involves combining pre-processed organic food waste with biosolids from the plant to increase the production of biogas. A joint project with local utility company National Grid will convert the biogas by-product into enough renewable natural gas for 5,200 New York City homes.

This project will help increase the city's use of renewable energy and reduce the amount of food waste and biosolids it sends to landfills, where they would otherwise emit greenhouse gases. In fact, as part of New York City's OneNYC sustainability plan, the city has a goal of zero-landfilling of biosolids by 2030. New York City currently produces 1,200 tons of biosolids a day – the business potential for turning all of those biosolids into a resource is huge. Biocatalyst systems that provide targeted microbes can also greatly enhance the digestion process, allowing more biogas to be generated.

Along with bioenergy, microbial fuel cells are an emerging technology that can also be used to generate electricity. A microbial fuel cell is a bio-electrochemical device that generates electricity through microbial respiration. In a wastewater treatment plant, microbes called exoelectrogens break down and metabolize carbon-rich sewage sludge to produce electrons that can be used to generate electricity, potentially reducing the energy input to a wastewater treatment plant. Using biosolids as inputs for energy production is an excellent example of operationalizing both the 'circular' and 'economic' aspects of a circular economy.

Unlocking the water in wastewater

Reusing treated wastewater is also starting to grow in importance, especially in light of UN Water's estimate that by 2025 1.8 billion people are expected to be living in countries and regions with absolute water scarcity.

Alternative approaches that reduce our reliance on groundwater sources and drinking water is imperative in the face of this impending crisis. A range of commercial sectors are responding to this need with wastewater reuse. For example, Heineken recently opened a plant in Northern Mexico – a region prone to severe droughts – that purifies the water used in production and reuses 30 percent of it in other processes. This model embodies the circular economy mantra of turning waste outputs into new inputs.

Despite the promising advancements in technology and the growing recognition of wastewater's resource recovery potential, the circular economy for wastewater has been slow to develop. Part of this is due to challenges with scaling up the quality of treated wastewater. For example, a major wastewater treatment plant in California sends a signification portion of its wastewater effluent to a nearby power plant to use as cooling water. For a region that is no stranger to drought, this efficient reuse of water eases pressure on groundwater resources and is a strong circular economy model that can be emulated across the country.

There is one hurdle, however; although the plant meets the regulatory requirements for ammonia levels in its effluent, the value of the wastewater would be higher if it could exceed those requirements and reduce the ammonia content below levels set by regulators. Ammonia in water can lead to ammonia-induced stress cracking in pipes, so lower ammonia levels would help the power plant use even more of the wastewater effluent for cooling without any concern for the lifecycle of its pipes.

The challenge for the wastewater treatment plant is to increase the value of its wastewater without the need for large capital investments to upgrade the plant, which inhibits adoption. Thinking beyond traditional tactics can lower the barrier to entry.

For example, the microbes that optimize nutrient recovery can be combined with insights from process modeling software to help a plant customize its treatment approach for different end users without building new infrastructure. The advanced process modeling tools determine the operational conditions needed to enhance treatment quality, and the added microbes do the work of executing on the plan. The resulting microbial solutions are more flexible for responding to changing circumstances than fixed infrastructure upgrades.

A comprehensive approach to the waste hierarchy can help us recognize wastewater as a vital resource and source of not only water, but energy, nutrients, and other recoverable by-products. Circular economy models for wastewater are the ideal vehicle for turning wastewater treatment plants into resource recovery centers. To hasten that paradigm shift, microbial technologies can be an affordable way to unlock the scalable value and treat wastewater not as a burden but as an opportunity.

Editorial

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Features (/features)

One Pipe, Many Problems

By **Dr. Malcolm Fabiyi (/staff/dr-malcolm-fabiyi)** 02:47PM June 11, 2018

Have you ever noticed a slight odour of sewage in the air after a heavy rainfall? Some of you will be bewildered by this question, but for those of you nodding vigorously, you probably live in one of many municipalities in North America with a combined sewer system, including large cities like New York City, Toronto, and Vancouver. Combined sewer systems collect rainwater runoff and sewage into one pipe.

Under normal conditions, the combined sewer system pipe will collect all of the wastewater and transport it to a sewage treatment plant for treatment. But this single-pipe system can get overwhelmed by high volumes of rainwater runoff, due to heavy rainfall or melting snow, resulting in untreated wastewater and stormwater being discharged directly into nearby bodies of water. When this happens it is called combined sewage overflow (CSO) and, according to the Environmental Protection Agency, it is a priority water pollution concern for the 860 U.S. municipalities with combined sewer systems. In 2016 the EPA estimated (https://ehp.niehs.nih.gov/EHP2048/#c26) that anywhere from 23,000 to 75,000 CSO events occur per year in the U.S. nationwide.

Beyond the smell, CSO presents a number of public health issues for affected communities. A study published in 2017 (https://ehp.niehs.nih.gov/EHP2048/#tab2) by the School of Public Health at the University of Illinois at Chicago tracked ER visits for gastrointestinal (GI) illnesses in Massachusetts as they related to CSO events from the years 2005 to 2008. The study concluded that in the 10 to 14 days following a CSO event visits to the ER for GI illnesses increased significantly. CSO introduces pathogens into the environment where people can come into contact (https://www.watercanada.net/ottawa-gets-real-time-control-for-cso-management/) with them through recreational water (used for swimming and boating), drinking water, or through contaminated soil (which can eventually contaminate drinking water sources).

In addition to the public health concerns, there are environmental impacts of CSO as well. CSO events can cause untreated wastewater to be released to surface water bodies leading to environmental damage such as algae blooms. Algae blooms can affect drinking water—they are a recurring problem in Toledo, Ohio (https://www.npr.org/sections/health-shots/2017/11/09/563073022/algae-contaminates-drinking-water), which draws its drinking water from Lake Erie. They can also cause widespread fish die-offs, disrupting the local ecosystem and harming commercial and recreational fishing.

When a CSO event takes place, a wastewater treatment plant faces two issues. First, an excess volume of wastewater reduces the amount of time available to adequately treat contaminants. Secondly, clarifiers in wastewater treatment plants remove solids from wastewater through sedimentation—basically the separation of denser bacteria solids through settling.

As a CSO event causes the flow of wastewater to rush through the infrastructure in significantly larger volumes, settling is disturbed, which can lead to a washout of the bacteria in the treatment plant and affect the facility's ability to effectively treat wastewater. The consequences of a washout may also include numerous environmental and health issues described previously, such as algae blooms and the release of harmful pathogens into recreational waters.

A plant's loss of its microbial community is tantamount to the crash of a computer's operating system. Fortunately, nature does provide us with solutions to boost a plant's processing speed and effectiveness within its existing footprint. Such solutions, including Drylet (http://www.drylet.com/products/aqua-assist-wastewater/)'s, can even upgrade its operating system so that settled solids form a compact blanket that sudden surges leave

mostly undisturbed. They eliminate the need for costly upgrades and help create more resilient infrastructure that can stand up to extreme weather events, such as hurricanes.

Combined sewage systems are vestiges of an aging infrastructure. They were considered advanced for their time but they need to be retired. As extreme weather events become more frequent, bringing heavier rainfalls in some places, combined sewer systems will continue to overflow, contributing to greater public health and environmental issues. Paris bore witness to this, earlier this year when the Seine River flooded for the second time in three years.

We need to upgrade our water infrastructure and rebuild combined sewer systems but that takes time and money, yet globally we are facing a massive infrastructure spending gap. For the water sector alone, U.S. governments will need to invest about $7.5 trillion USD (https://www.mckinsey.com/industries/capital-projects-and-infrastructure/our-insights/bridging-global-infrastructure-gaps) over the next decade to meet infrastructure needs—a massively expensive, disruptive and time-consuming undertaking. In the interim, we need cost-effective solutions that can help these aging combined sewer systems cope.

In this context, governments and waste management authorities should turn their attention to solutions offered by nature. Their citizens will thank them for the resulting reductions in health and environmental risks—and better-smelling cities.

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